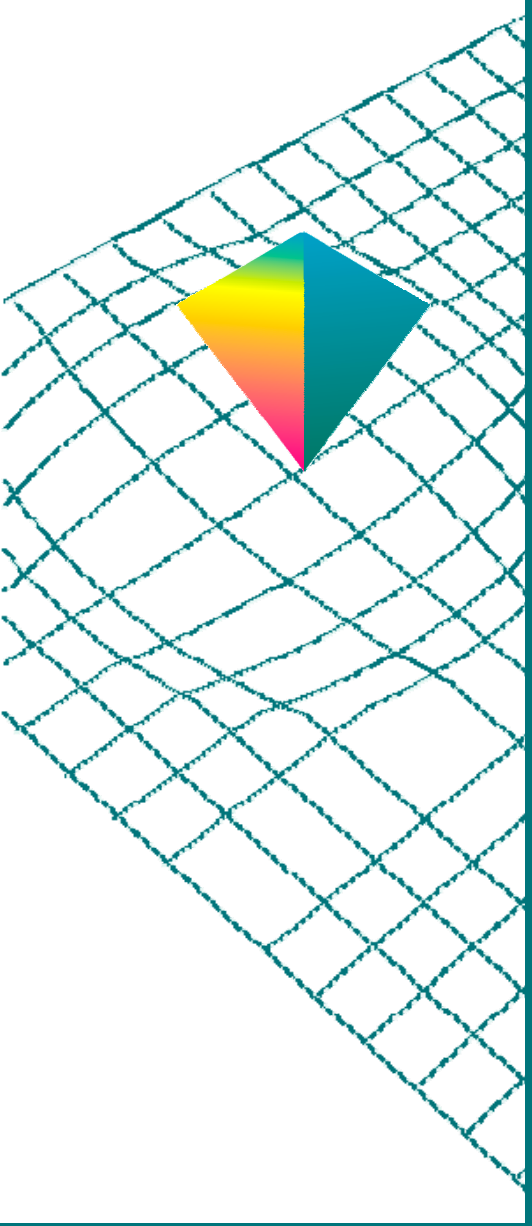
TECHNISCHE UNIVERSITÄT
ILMENAU

50. Internationales Wissenschaftliches Kolloquium

September, 19-23, 2005



Maschinenbau von Makro bis Nano / Mechanical Engineering from Macro to Nano

Proceedings

Fakultät für Maschinenbau /
Faculty of Mechanical Engineering

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=15745

Impressum

Herausgeber:	Der Rektor der Technischen Universität Ilmenau Univ.-Prof. Dr. rer. nat. habil. Peter Scharff
Redaktion:	Referat Marketing und Studentische Angelegenheiten Andrea Schneider Fakultät für Maschinenbau Univ.-Prof. Dr.-Ing. habil. Peter Kurtz, Univ.-Prof. Dipl.-Ing. Dr. med. (habil.) Hartmut Witte, Univ.-Prof. Dr.-Ing. habil. Gerhard Linß, Dr.-Ing. Beate Schlütter, Dipl.-Biol. Danja Voges, Dipl.-Ing. Jörg Mämpel, Dipl.-Ing. Susanne Töpfer, Dipl.-Ing. Silke Stauche
Redaktionsschluss: (CD-Rom-Ausgabe)	31. August 2005
Technische Realisierung: (CD-Rom-Ausgabe)	Institut für Medientechnik an der TU Ilmenau Dipl.-Ing. Christian Weigel Dipl.-Ing. Helge Drumm Dipl.-Ing. Marco Albrecht
Technische Realisierung: (Online-Ausgabe)	Universitätsbibliothek Ilmenau ilmedia Postfach 10 05 65 98684 Ilmenau
Verlag:	isle Verlag ISLE, Betriebsstätte des ISLE e.V. Werner-von-Siemens-Str. 16 98693 Ilmenau

ISBN (Druckausgabe):	3-932633-98-9	(978-3-932633-98-0)
ISBN (CD-Rom-Ausgabe):	3-932633-99-7	(978-3-932633-99-7)

Startseite / Index:
http://www.db-thueringen.de/servlets/DocumentServlet?id=15745

50. Internationales Wissenschaftliches Kolloquium
Technische Universität Ilmenau
19.-23. September 2005

Prediction of the Tool Wear for Fine Finish Turning of the Harden Mold Steel SKD11 by Ceramic Cutting Tools

Wei- Shin, Lin

Abstract

In order to monitoring the tool wear characteristics during the fine finish turning process of the hardened mold steel SKD11 by ceramic cutting tools, the abductive polynomial network is used to construct a tool wear prediction model. Abductive polynomial network is constituted with several function nodes; these function nodes can be self-organizing into the optimal network structures according to the predicted square error (PSE) criteria.

It is shown that the abductive polynomial network can correctly correlate the input variables (cutting speed, feed rate and cutting time) with the output variable (tool wear). Based on the tool wear prediction model constructed, the wear amount of the ceramic cutting tools can be predicted with reasonable accuracy if the turning conditions are given and it is also consistent with the experimental results very well. The manufacturing engineers can then according to the prediction results to execute the process planning, decide the manufacturing process and the tool change time preventing the cutting tool from over-worn or failure when it is in use.

Introduction

A major draw back of hard turning is the occurrence of wear at the cutting edge. Tool wear governs the geometrical and surface quality of the machined parts. In particular, tool wear requires close monitoring in finish turning of harden mold steels. Wear development during machining can reach unacceptable levels very fast in some cutting conditions resulting in poor surface finish. The prediction and detection of tool wear before the tool causes any damage on the turning surface becomes highly valuable in order to avoid loss of product, damage to the machine tool and associated loss in productivity.

Abductive networks built upon the abductive modeling technique are able to represent complex and uncertain relationship between input and output variables【1,2】. Basically, abductive networks are composed of a number of polynomial functional nodes and are organized into several layers. The best network structure, number of layers and types of functional nodes can be automatically generated by using a predicted square error (PSE) criterion 【3,4】. In other words, unlike most approaches of regression or neural networks, the abductive modeling technique can synthesize an optimal network architecture automatically, where it is not necessary for the user to specify the network hierarchy in advance. In addition, the iterative tuning process required in regression or neural networks is greatly reduced in the abductive approach. It has also been demonstrated that the accuracy of predictions made by abductive networks is much higher than that of neural networks 【1,2】. In this study, we have proved that the flank wear estimation model constructed by the abductive network is able to predict the flank wear accurately.

Experiment and results

A training database with regard to process parameters and turning performance is required to build an abductive network for modeling the tool wear and surface roughness through the turning process. The training database will be obtained from cutting experiments. The experimental condition for cutting speed will be V = 50, 150, 250 m/min and feed rate will be f = 0.03, 0.09, 0.15 mm/rev. A number of turning experiments were carried out on the CNC lathe with a ceramic insert to turning the harden mold steel SKD11. The hardness of the SKD11 was HRC 60-62.

Based on the developed training database, the abductive network for predicting tool wear was shown in Fig. 1

After calculating the error between the experimental value and predicted value, we can determined that the root mean square error was 0.76 %. The error is very reasonable.

From Fig. 2, it can be found that the error between the predicted values and the experimental values of tool wear is rather small, which indicates that the prediction model can be used accurately on the prediction of tool wear.

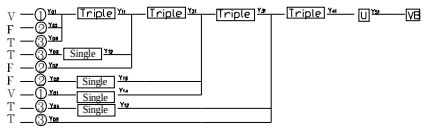


Fig. 1 Abductive network for tool wear prediction

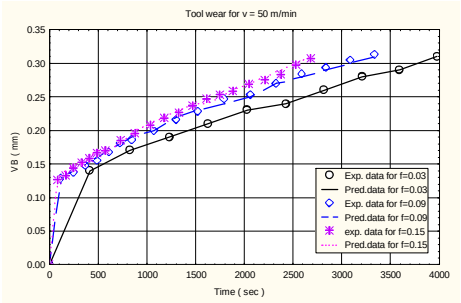


Fig. 2 Tool wear for V = 50 m/min

CONCLUSION

1. A prediction model, based on the abductive network, for assessing tool wear can accurately predict. Therefore, we suggest that the tool wear monitoring device constructed by abductive network can be effectively used in tool wear monitoring of automated machining environment.
2. The tool wear for hard turning of SKD11 by ceramic tools are all increased with the cutting time and feed rate.
3. Because the feed rate change may affect the tool wear and surface roughness, when implementing process planning for measure shall be taken to minimize the feed rate, in order to secure an optimal surface roughness.

REFERENCE

【1】 Montgomery, G. J., and Drake, K. C., “Abductive Reasoning Network”, *Neurocomputing*, Vol. 2, pp. 97-104 (1991).

【2】 Peirce, C., *Abduction and Induction, Philosophical Writing of Peirce*, ed. by Buckler, Dover, New York (1995).

【3】 Barron, A. R., *Predicted Square Error: A Criterion for Automatic Model Selection, Self-Organizing Methods in Modeling: GMDH Type Algorithms*, ed. by Farlow, S. J., Marcel-Dekker, New York (1983).

【4】 Barron, R. L., Mucciardi, A. N., Cook, F. J., Craig, J. N. and Barron, A. R., *Adaptive Learning Networks: Development and Application in the United States of Algorithms Related to GMDH, Self-Organizing Methods in Modeling: GMDH Type Algorithms*, ed. by Farlow, S. J., Marcel- Dekker, New York (1984).

Authors:

Wei- Shin, Lin
Department of Mechanical Manufacturing Engineering,
National Formosa University,
64, Wunhua Rd., Huwei, Yunlin 632, Taiwan

E-mail: linwhs@nfu.edu.tw